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Radiation burst from a single γ-photon field

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Abstract

The radiation burst from a single γ-photon field interacting with a dense resonant absorber is studied theoretically and experimentally. This effect was discovered for the fist time by P. Helisto and it was named the "gamma echo." The echo is generated by a 180 phase shift of the incident radiation field, attained by an abrupt change of the position of the absorber with respect to the radiation source during the coherence time of the photon wave packet. Three distinguishing cases of the gamma echo are considered; i.e., the photon is in exact resonance with the absorber, close to resonance (on the slope of the absorption line), and far from resonance (on the far wings of the resonance line). In resonance the amplitude of the radiation burst is two times larger than the amplitude of the input radiation field just before its phase shift. This burst was explained by Helisto as a result of constructive interference of the coherently scattered field with the phase-shifted input field, both having almost the same amplitude. We found that out of resonance the scattered radiation field acquires an additional component with almost the same amplitude as the amplitude of the incident radiation field. The phase of the additional field depends on the optical thickness of the absorber and resonant detuning. Far from resonance this field interferes destructively with the phase-shifted incident radiation field and radiation quenching is observed. Close to resonance the three fields interfere constructively and the amplitude of the radiation burst is three times larger than the amplitude of the input radiation field.

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